done on account of the large amount of purulent secretion which had accompanied the case and which it was suspected came from empyema of some or all of the accessory nasal sinuses. The discharge would therefore continue after the removal of the tumor, and it was feared would greatly hinder the proper healing of the line of incision. The measurement of the tumor immediately after removal was 6½ x 2½ x 1½ cm. The pedicle was 4 cm. long and of the same width as the tumor itself. An examination of the eye-ground on left side showed nothing but slight haziness of the fundus.

The patient needed considerable stimulation for two or three days. The first packing was removed after twenty-four hours and a lighter packing substituted. Very profuse purulent discharge was present for the first few days, but little bleeding. Second packing was removed in twenty-four hours and nose was left open. Nostrils were washed frequently with warm boric solution. Primary healing took place in entire line of incision except near canthus of left eye. At this point a little pus was forced through and a small fistula established, which, however, healed in two or three weeks. Patient was discharged from the hospital ten days after operation, and continued to come to dispensary. Recovery and healing were uninterrupted.

Examinations of the site of the tumor have been made since then at intervals of three or four months, but no recurrence has been observed —a period of five and a half years.

The interest in this case lies in the comparative rarity of the tumor in the nose unaccompanied by similar growth in the nasopharynx, and also in the satisfactory result secured by full exposure of the mass and its thorough removal.

THE CLINICAL VALUE OF BLOOD EXAMINATIONS IN APPENDICITIS. A STUDY BASED ON THE EXAMINATION OF ONE HUNDRED AND EIGHTEEN CASES AT THE GERMAN HOSPITAL, PHILADELPHIA.[1]

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THE communication which I have the honor of presenting to the Association, by the invitation of your Secretary, is offered with no slight hesitancy, for, at first glance, it must seem somewhat needless to approach a topic already so familiar to all surgeons, thanks largely to the careful studies made by Cabot, Greenough, and others during the past five years. Still, there are reasons which appear to justify a further consideration of this topic. The fact, for example, that certain of the blood changes in appendicitis have been either overlooked or regarded as trivial, in comparison with other more conspicuous features of the blood picture, and the tendency of some clinicians to attach undue diagnostic and prognostic significance to the blood report, and of others to regard it as untrustworthy—these reasons, perhaps, are of sufficient weight to render the theme less hackneyed than its title leads one to infer.

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[1] Read by invitation before the American Surgical Association, 1901.

METHODS AND TECHNIQUE. The conclusions embraced in this report are based upon data derived from the examination of 118 cases of appendicitis in Dr. John B. Deaver's wards at the German Hospital. All these cases were treated surgically, and the statistics relating to the blood changes represent the condition of the blood before operation, usually at the time immediately after the patient's admission to the hospital. The majority of patients were examined but once, and in the few instances in which multiple estimates were made the data of the initial examinations only were included in the analysis.

Most of the examinations were made by various members of the hospital's house-staff, a few by myself. The services of Dr. G. P. Müller, senior resident pathologist at the hospital, in tabulating and classifying the clinical histories of the patients, have been invaluable.

The hæmoglobin estimates were made with a von Fleischl hæmometer, which, for the sake of greater accuracy, was enclosed in a light-proof box provided with a camera-tube limiting the observer's field of vision to the mixing chamber of the instrument. As a rule, a number of different readings were made by several examiners, and the average of the figures most closely corresponding taken as the final estimate.

Both the erythrocytes and the leucocytes were counted with the same instrument, a Thoma-Zeiss erythrocyte pipette, Toisson's solution being used for diluting the blood, generally in the proportion of 1 : 200. Zappert's counting-slide, having a ruled surface equalling that of 3600 of the small squares of the original Thoma-Zeiss cell, was employed in nearly every instance. The erythrocytes in at least 200 and the leucocytes in not less than 3600 of these small squares were counted, to serve as a basis for the calculation of the total number of cells to the cubic millimetre of undiluted blood.

Differential counts were made only in exceptional instances, in those, for example, with a leucocytosis, in which the symptoms did not suggest appendicitis as a factor of the leucocyte increase, and in those with high-grade anæmia. An absence of any important qualitative changes affecting the blood cells in this disease was thought to justify the omission of differential counting as a routine step in all cases in which the symptoms were definite. In those instances in which the percentages of the different forms of leucocytes were calculated, the figures represent the averages of counts of at least 250 cells, made from heat-fixed films, stained with Ehrlich's triple stain, containing acid fuchsin, methyl-green, and orange-G, CLASSIFICATION. From a hæmatological view-point all forms of appendicitis may be conveniently classified in two general groups: purulent and non-purulent. The first group includes simple catarrhal and interstitial inflammations of the organ, unattended by abscess formation, by gangrene, and by general peritonitis, singly or combined. The second group comprises cases with pus foci resident in or primarily arising from the appendix, with or without a complicating appendicular gangrene and general peritoneal inflammation. It must be admitted that such a vague classification as this is useful only in so far as it relates to the blood changes to be detected by routine clinical examinations—changes by the aid of which the surgeon endeavors to determine the presence or absence of suppuration and peritonitis, and to trace the progress of the lesion from day to day.

Of the 118 cases included in this report, 38 (or 32.2 per cent.) were unattended by pus formation, while in the remaining 80 (or 67.7 per cent.) this condition prevailed, sometimes with and sometimes without further inflammatory changes. These figures, of course, do not represent the usual ratio between the two forms of the disease just specified, since the cases here collected were not examined in an unbroken, consecutive series.

The features of the blood changes of greatest clinical interest in this disease are the anæmia by which it may be accompanied, and the behavior of the leucocytes, the former being sometimes so decided as to constitute a symptom demanding recognition and serious consideration, and the latter being of prime interest in relation to the diagnosis and the prognosis of the attack.

THE ANÆMIA OF APPENDICITIS. Apparently most writers regard this subject as one of comparatively trivial importance, for beyond the general observation that in chronic cases, presumably septic, a variable decrease in the hæmoglobin percentage and in the number of erythrocytes may occur, the question thus far has been dismissed with but casual notice. The fact, however, should not be ignored that the associated anæmia may be so marked as to constitute a symptom demanding careful attention, even should it not be of sufficient gravity to retard convalescence or to endanger the patient's life.

(*a*) *Hæmoglobin.* Practically every case of appendicitis, whatever its character, shows a variable degree of hæmoglobin loss, this decrease occurring with about equal frequency in both the catarrhal and the suppurative forms of the disease, although in the latter it tends to become more striking in the individual case. Speaking in averages, it will be found that the hæmoglobin is diminished to at least one-half of the normal standard in approximately one case in every ten (10.1 per cent.), while in an occasional instance it falls to a figure which the operators are accustomed to regard as perilously low—

40 per cent. or less—in about three cases (2.5 per cent.) out of every hundred. The fact that such low figures are encountered, although but rarely, seems sufficient to call for a routine hæmoglobin test in all cases to be treated surgically, for should the surgeon meet with such a profound oligochromæmia in a patient whose other symptoms demand the use of the knife, the advisability of an operation might appear to him questionable. Not being a surgeon, I cannot presume to discuss this technical point, but simply draw attention to the fact as suggestive, if not really important. It may be added that, judging from the meagre data at my command, an extreme hæmoglobin loss does not appear, *per se*, to be dangerous, since uninterrupted recovery took place in all the three patients of this series in whom hæmoglobin readings of 40 per cent. or lower were made. Positive conclusions, however, are scarcely justifiable, from so small a number of examinations. Judging from this series the average hæmoglobin loss in all forms of appendicitis is about 30 per cent., the average readings for the 118 cases being 70.1 per cent. of normal, or 69.1 per cent. for the catarrhal, and 70.1 per cent. for the suppurative forms.

(*b*) *Erythrocytes.* The erythrocyte loss, save in exceptional instances, is inconspicuous, since in about three out of every five cases (or in 63.5 per cent.) the number of these cells ranges between 4,000,000 and 5,000,000 to the cubic millimetre, while the latter count is exceeded in about one case in every ten (or in 12.7 per cent.). The average loss for the 38 catarrhal cases was 16.2 per cent. (average count 4,186,846), and for the 80 suppurative cases 11.9 per cent. (average count, 4,400,145), while the most striking examples of oligocythæmia in the individual case were practically equal in both forms—59 per cent. decrease in the non-suppurative and 58 per cent. loss in the suppurative, figures corresponding to counts of 2,050,000 and 2,100,000 per cubic millimetre respectively.

These results tend to show that, contrary to the current view, patients suffering from catarrhal appendicitis may be found to be anæmic just as frequently as those suffering from forms of the disease associated with abscess formation and easily recognized symptoms of septicæmia—a characteristic with which I have been frequently impressed long before this attempt was made to analyze the statistics of the blood counts. Perhaps the fact that the majority of these non-suppurative appendicitides were of chronic character, occurring in patients whose constitutions, undermined for a long period, were greatly debilitated, may serve to explain the frequency of anæmia in this variety of disease. Thus it appears that this factor of inadequate blood production is quite as active in provoking anæmia as is the element of sepsis, which is largely responsible for the blood destruction in suppurative appendicitis.

(*c*) *Color Index.* The color index, or the figure used to indicate the richness in hæmoglobin of the individual erythrocyte, is usually found to be moderately subnormal, ranging from about 0.70 to 0.80 in the great majority of counts. The index for the total 118 cases of this series averaged 0.82 plus, or about 18 points below the arbitrary standard, 1.00; in the 38 non-suppurative cases it was 0.82, and in the 80 with abscess, 0.79. The foregoing data apply, of course, only to averages, but they tend to show that an anæmia of the ordinary secondary type prevails in appendicitis—that is, one in which the hæmoglobin loss is usually somewhat relatively greater than that of the corpuscles. In the individual case, however, the index may fall to quite as low a figure as that commonly found in chlorosis, to 0.53, in one of these cases for example; or, on the other hand, it may rise to as high a figure as that which prevails in typical pernicious anæmia, to 1.50 in another case in the series, for instance.

In cases with severe anæmia deformities of shape and size were commonly noted, but neither nucleated erythrocytes nor decided evidences of atypical staining were observed. The number of stained specimens examined, however, was too small to attach to these remarks any value regarding the occurrence of erythroblasts and of polychromatophilic cells. There is no good reason why both should not be found in cases in which the anæmia is of a sufficiently grave type.

The range of the hæmoglobin and erythrocytes is illustrated by the following table:

TABLE I.—HÆMOGLOBIN AND ERYTHROCYTES.

Hæmoglobin, percentage.	Simple catarrhal and interstitial forms. (38 cases.)			Cases with abscess, gangrene, or general peritonitis. (80 cases.)		
	Acute.	Chronic.	Total.	Acute.	Chronic.	Total.
Above 100 per ct.	1	0	1	0	0	0
90 to 100 "	0	0	0	4	0	4
80 " 90 "	3	6	9	14	3	17
70 " 80 "	4	5	9	26	0	26
60 " 70 "	3	8	11	17	0	17
50 " 60 "	5	1	6	6	0	6
40 " 50 "	2	0	2	6	1	7
30 " 40 "	0	0	0	3	0	3
Highest,	102 per ct.	86 per ct.	102 per ct.	98 per ct.	90 per ct.	98 per ct.
Lowest,	45 "	60 "	45 "	38 "	48 "	38 "
Average,	69 "	72.7 "	69.1 "	71.7 "	76 "	70.1 "
Erythrocytes per c. mm.						
Above 5,000,000	1	3	4	9	2	11
4,000,000–5,000,000	10	13	23	50	2	52
3,000,000–4,000,000	6	4	10	12	0	12
2,000,000–3,000,000	1	0	1	5	0	5
Highest,	6,660,000	5,620,000	5,660,000	5,710,000	5,240,000	5,710,000
Lowest,	2,050,000	3,100,000	2,050,000	2,100,000	4,490,000	2,100,000
Average.	4,240,389	4,348,000	4,186,846	4,872,500	4,925,000	4,400,125

THE RANGE OF THE LEUCOCYTES. The numerical fluctuations of the leucocytes constitute, by all odds, the most important feature of the blood picture associated with this disease, and the behavior of these cells has been regarded as a sign both of diagnostic and prognostic value, to interpret with more or less accuracy the pathological condition of the local lesion, and to furnish information as to the presence or absence of complications. To what extent the leucocyte count can be relied upon as a dependable clinical sign, and to what extent it may prove misleading, in routine clinical work, I have attempted to determine by the following inquiry:

In the catarrhal and interstitial forms of appendicitis, without abscess or any of its consequences, the number of leucocytes, as a rule, does not exceed the maximum normal standard (10,000 per cubic millimetre), and, indeed, is not infrequently much below this figure. In a fairly large proportion of cases, however, exceptions to this rule must be noted, for counts of 12,000, 15,000, or, rarely, even higher may sometimes be encountered. In the present series, 39.4 per cent. of the cases (15 cases) showed a leucocyte increase ranging between 10,000 and 17,000, the latter being the maximum, while in 60.5 per cent. (23 cases) the counts were below 10,000, the minimum estimate being 1600. It may be observed in passing that the maximum count of the individual case of catarrhal appendicitis is somewhat lower than the average count in the purulent variety, to be considered later.

It does not seem unreasonable to attribute the majority of these high counts to the presence of a local non-purulent inflammation restricted to the peritoneal covering of the appendix, since a circumscribed peritonitis of this sort is not uncommon in this form of the disease, and is quite sufficient to account for the leucocytosis. In other cases the possibility that the increase represents simply a blood-finding of the associated anæmia must naturally be suggested; or, again, that it may be the result of blood inspissation, for the production of which copious emesis or purging may have been the factors.

In cases with abscess, gangrene, or general peritonitis a well-marked leucocytosis is found in most instances, the majority of appendicular abscesses raising the count to 15,000 or 20,000 per cubic millimetre, and sometimes to even a higher figure. It is, however, a well-recognized fact that, should the pus focus happen to be so effectually walled off that little or no absorption of the toxic material can occur, such a decided increase may fail to develop. On the other hand, leucocytosis may also be absent, or, indeed, leucopenia may be found, in profoundedly septic patients, in whom the effects of the poison have proved so crippling that reaction is stifled. However active may have been this factor in the experience of others, in my own experience it has been rarely found that a patient's resisting powers were so effectually overcome that leucocytosis was prevented, for in only two out of my twelve fatal cases (or in 16.6 per cent.) was a well-defined leucocytosis absent, the counts in these two cases being 6000 and 11,200 respectively. In the other ten counts the number of leucocytes ranged from a minimum of 14,200 to a maximum of 58,500, and averaged 19,400 per cubic millimetre.

TABLE II.—FATAL CASES.

No.	Hæmoglobin.	Erythrocytes	Leucocytes.	Remarks.
1	71	4,580,000	11,200	
2	98	5,420,000	14,600	36 hours after operation.
	98	5,460,000	10,200	6 days " "
	96	5,430,000	16,800	9 days " "
3	88	5,280,000	58,500	
4	100	5,120,000	15,200	General peritonitis.
5	85	4,370,000	22,800	
6	75	4,550,000	16,000	
7	68	4,470,000	19,600	
8	79	3,840,000	21,500	
9	94	5,000,000	6,000	
10	95	4,110,000	14,200	Immediately after operation.
	90	4,150,000	20,400	1 day after operation.
11	75	4,970,000	14,800	
12	46	2,760,000	11,600	

From these figures it is natural to infer that the degree of leucocytosis, as determined by a single examination, cannot be relied upon as a prognostic sign. If, however, by repeated examinations a progressive increase in the number of leucocytes is detected, it may generally be concluded that the pus collection has become more extensive or that a general peritonitis has been excited. Such accidents as these were heralded in three cases of this series, by an increase varying from 6600 to 14,000 cells to the cubic millimetre in excess of the number previously counted. Perforation is usually accompanied by an abrupt rise in the leucocytes, although it is to be recalled that in greatly debilitated individuals this increase may be absent, or, indeed, a sudden decrease may occur. Personally, I have not investigated this question with sufficient thoroughness as to warrant definite conclusions as to the behavior of the leucocytes under these circumstances.

Absence of leucocytosis has also been observed in cases in which the pus focus is of small extent, but small abscesses are by no means always associated with low counts, for the intensity of the systemic reaction provoked by the abscess, and not the extent of the latter, appears to be the more active determining factor of the increase.

In the present series the count for purulent cases averaged 17,453, or somewhat less than double the average figure for the catarrhal variety. The leucocytes were in excess of 15,000 per cubic millimetre in 62.5 per cent., or 50 of the counts, and in excess of 20,000 in 25 per cent., or 20 counts, reaching a maximum of 58,500 in a single instance. In

37.5 per cent., or 30 counts, the number of cells was below 15,000, the lowest estimate being 6000.

In the few cases with leucocytosis in which differential counts were made it was found that the increase was due chiefly to a decided absolute and relative increase in the polynuclear neutrophiles, the lymphocytes, the large mononuclear forms, and the eosinophiles being relatively diminished. Neither myelocytes nor basophilic leucocytes were observed in any of the examinations.

The following table represents the range of the leucocytes in the 118 cases examined:

TABLE III.—LEUCOCYTES.

Leucocytes per c.mm.	Simple catarrhal and interstitial forms. (38 cases.)			Cases with abscess, gangrene, or general peritonitis. (80 cases.)		
	Acute.	Chronic.	Total.	Acute.	Chronic.	Total.
Above 50,000	0	0	0	1	0	1
40,000 to 50,000	0	0	0	0	0	0
35,000 " 40,000	0	0	0	2	0	2
30,000 " 35,000	0	0	0	0	0	0
25,000 " 30,000	0	0	0	3	0	3
20,000 " 25,000	0	0	0	14	0	14
15,000 " 20,000	4	0	4	30	0	30
10,000 " 15,000	2	9	11	19	3	22
5,000 " 10,000	8	9	17	7	1	8
Below 5,000	4	2	6	0	0	0
Highest,	17,000	15,000	17,100	58,500	14,600	58,500
Lowest,	1,600	2,400	1,600	6,000	8,800	6,000
Average,	9,124	9,190	9,158	17,718	12,425	17,453

To recapitulate, an analysis of the foregoing data appears to warrant the following conclusions:

1. The average case of appendicitis before operation shows a loss of about 30 per cent. of hæmoglobin and of more than half a million erythrocytes per cubic millimetre. Occasionally the anæmia is of a grade so high that it appears to constitute in itself a serious complication and to raise a doubt as to the safety of surgical interference, should the latter otherwise be indicated. Doubts on this score, however, have not been justified by the records of the cases included in this series.

2. Moderate leucocytosis may occur both in the absence and in the presence of an abscess and its consequences. It accompanies about 35 per cent. of non-purulent and 90 per cent. of purulent cases.

3. Leucocyte counts ranging between 10,000 and 15,000 or 17,000 cannot be depended upon to reflect the nature of the local lesion, since this degree of increase may be found both in mild catarrhal and in purulent cases. Counts of 20,000 or more almost invariably indicate the presence of pus, gangrene, or general peritonitis, one or all.

4. Leucocytosis may be absent both in trivial catarrhal and in fulminant cases, as well as in forms of circumscribed abscess.

5. In operative cases thorough evacuation of the abscess is followed within a few days by a decline to normal in the number of leucocytes, provided that the recovery of the patient is uneventful. Persistence of a leucocytosis after the third or fourth day following the operation may usually be attributed either to undrained pus pockets, to general peritonitis, or to both of these factors.

VALUE OF THE BLOOD CHANGES AS DIAGNOSTIC AND PROGNOSTIC SIGNS. It is obvious that the range of the leucocytes, if correlated with other clinical symptoms, may serve as a diagnostic sign of definite value. On the other hand, the fact cannot be emphasized too forcibly that an absence of leucocytosis, except in conspicuously septic patients, signifies nothing definite.

Regarding a leucocytosis of 20,000 or higher as a practically certain indication of pus or its consequences, in my experience in one out of every four cases of appendicular abscess the diagnosis is justified by the behavior of the leucocytes. This may seem a most conservative estimate of the value of the leucocyte count in recognizing such a condition, and its acceptance certainly restricts the utility of the blood count as a diagnostic aid, but repeated observations have proved the fact that a leucocytosis of less than 20,000, or at the minimum, 17,000, cannot be relied upon as a trustworthy sign of pus, although, as already pointed out, pus may exist with much lower leucocytoses.

In a patient unmistakably septic absence of leucocytosis should be interpreted as a sign of an intense infection, the prognosis of which is more likely grave than favorable. A high leucocytosis in such instances does not necessarily indicate a favorable prognosis, but simply represents an intense infection coupled with normally active resisting powers on the part of the patient.

Absence of leucocytosis in a patient with mild, indefinite symptoms is a clinical sign of no tangible value in so far as it may serve in detecting the presence of pus, since a large abscess, if thoroughly circumscribed, may exist without causing the slightest increase in the number of leucocytes.

In cases treated surgically the adoption of daily leucocyte counting as a routine procedure during the first week after the operation furnishes the surgeon with definite information regarding the progress of the case, since the advent of complications or the failure to secure complete evacuation of pus foci may be detected by the persistence of or an increase in the leucocytosis.

Unfortunately, it happens that just those conditions which bear the closest resemblance to appendicitis, as a rule, give rise to blood changes identical with those found in the latter disease, so that the value of the blood count as a means of differential diagnosis is greatly limited. Thus, leucocytosis is the rule in such conditions as ovarian abscess, pyosalpinx, ectopic pregnancy, perinephritic abscess, hepatic abscess, empyema of the gall-bladder, and malignant disease of the cæcum, all of which have been confused with appendicitis. Such a large proportion of renal and hepatic colics are associated with inflammatory complications which provoke leucocytosis that neither of these conditions can be distinguished with any degree of confidence from appendicitis simply by the examination of the blood. Acute gastritis is sometimes accompanied by a well-marked leucocytosis, and sometimes by none at all, so that the blood count cannot be relied upon as a clue in distinguishing this disease from appendicitis. The same is true of dysmenorrhœa, in which disease uterine inflammatory changes may be the factor of a leucocyte increase. Should the diagnosis lie between appendicitis and enteric fever, the former is suggested by the presence of a leucocytosis, since this sign practically never occurs in typhoid, except in the event of some obvious complication, such as hemorrhage from the bowel or perforation.

In doubtful cases a leucocytosis is sufficient to exclude such non-inflammatory lesions as simple enteralgia, lead colic, ovarian neuralgia, an ovarian cyst, and a movable kidney.

In conclusion, allow me to urge the more frequent employment of hæmatological examinations, not only for the light which they throw upon the coexisting anæmia present in some instances, but as a means of detecting with certainty a purulent from a non-purulent appendicular lesion in a fairly large percentage of cases. The limited number of non-inflammatory conditions from which this disease may be distinguished by the behavior of the leucocytes should also be remembered. The surgeon who attempts to use the blood count in appendicitis as a definite, pathognomonic sign soon will run afoul of diagnostic disasters, but he who regards it as only a symptom, invariably to be correlated with other equally if not more important clinical manifestations, cannot fail to find this method of inquiry of signal value in routine clinical surgery.

THE BLOOD COUNT AT HIGH ALTITUDES.[1]

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assisted by
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The study of the blood and its changes is extremely interesting. You will pardon the writer for again calling your attention to its consideration. We were made familiar with the number, size, color, shape,

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[1] Read before the American Climatological Association, 1901.